(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 965 764 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
22.12.1999 Bulletin 1999/51

(51) Int. Cl.[6]: **F15B 15/26**

(21) Application number: **99111560.1**

(22) Date of filing: **15.06.1999**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **17.06.1998 IT MI981387**

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(54) Spring lock device

(57) A spring lock device (10) to prevent axial and/or rotational motion of a shaft or rod member (12); the device comprises a locking element in the form of a coil spring (16) arranged in a casing (10), is loosely disposed around the shaft or the rod (12), to provide a locking action in a required position. A thrust member (18) operatively connected to a pressure actuated control device (19) acts on the arms (16A, 16B) of the coil spring (16) to grip the rod (12) preventing any sliding and/or rotational movement.

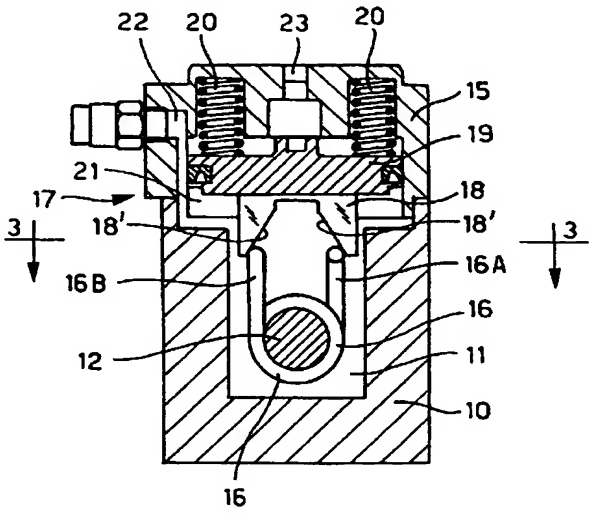

FIG. 1

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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a spring lock device for high loads provided for preventing axial and/or rotational motion of a rod or elongated member in respect to a housing that surrounds and through which the same rod is axially sliding and/or rotates; in particular, the invention is directed to a spring lock device for locking a shaft or a rod of a machine, or of an actuator, for example a pneumatic cylinder or for any other application in which it is required to allow or to lock a movement of a member connected to or movably supported by a shaft or by the same rod.

[0002] The spring lock device according to the invention is particularly suitable for applications in any field; however, only by way of illustration of the innovative features of the invention, the spring lock device will be described hereinafter with reference to locking of a linearly movable shaft or rod of a pneumatic cylinder, without this having to be considered as limiting as regards other possible applications.

STATE OF THE ART

[0003] As is known, in pneumatic actuation systems usually available for moving mechanical members it is often necessary to safety lock a load or a movable member, keeping it in a predefined position and/or condition without the load or the mechanical member being able to move and/or rotate under its own weight or as a result of the thrust exerted by an actuator.

[0004] In this connection lock devices for shafts have been proposed comprising locking jaws suitably hinged and provided with aligned holes for the shaft against which the two jaws are resiliently biased and urged to prevent any movement. A pneumatically actuated thrusting member acts on the free ends of the jaws against counteraction springs to release the shaft, thus allowing again a linear movement. A locking device of this kind is described for example in EP-A-0,824,994.

[0005] Although devices of this kind are able to achieve correct positioning of a shaft or a load at the locked condition, in practice they provide relatively small locking forces as a result of simple misalignment of the locking jaws. Moreover, since each jaw is acting against the peripheral surface of the shaft with an edge of a side surface, high locking forces could cause irreparable damage to of the shaft or the rod to be locked; moreover the locking force of each jaw acts over a small arc of a circle, exerting locally a high pressure force which tends to engrave or to cut into the surface of the shaft.

[0006] Locking devices of this kind therefore require that the rod or the shaft to be made of, or lined with a very hard material, by using special steel or by subjecting the shaft to a rolling or surface hardening process. In all these cases, these lock devices provide a clamping force which is equal to or slightly greater than the thrust exerted by a so-called "equivalent cylinder", where "equivalent cylinder" is understood as meaning the thrust, in kilogrammes, exerted by a pneumatic cylinder in accordance with existing standards, having a diameter of the rod corresponding to the shaft to be locked.

[0007] Purely by way of example, a shaft of 12 mm diameter, in accordance with the standards referred to above, corresponds to a cylinder having a diameter of 32 mm, to develop a thrust of about 48 kg with an air pressure of 6 atm, which must therefore be overcome by the locking device.

[0008] Unless the lock device is made with larger dimensions, with the risk of damaging the shaft or the rod against which the locking action is to be exerted, the currently known locking devices are unable to provide particularly high locking forces or a sufficiently high safety factor, for the reasons mentioned above.

[0009] Spring lock devices are also known, to prevent axial and/or rotational motion of a rod with respect to a housing through which the rod is sliding or rotate; the device comprises at last one coil spring encircling or fitted over the rod, in which the coil spring has inside diameter slightly differing in respect to the peripheral diameter of the rod, and in which control means are provided for causing the coil spring to grip or disengage the rod, preventing or respectively allowing a relative movement between the housing and the same rod.

[0010] Spring lock devices of the type referred to above are shown for example in US 4.201.096, US 3.874.480 and US 4.425.987; conversely, US 4.045.081 and EP 0 458 457 and the previously mentioned US 4.201.096 suggest the use of a pair of opposite coiled spring fitted over a shaft to prevent movement by a frictional force.

[0011] Although the use of spring lock devices has been suggested by the above mentioned documents, in which the locking forces are exerted by inside tensioning of a spring having an inner diameter usually in close contact with the peripheral of the rod, none of them describes or suggests the use of a spring lock device suitable for selectively generating high load locking forces by a device of single and reliable design.

OBEJECT OF THE INVENTION

[0012] Therefore, the main object of the present invention is to provide a pneumatically controlled spring lock device which does not use any locking jaw, and which at the same time is able to provide the required high load locking force without damaging, by using at least one or more coil springs suitably and simply fitted over a shaft or a rod to be locked.

[0013] A further object of the present invention is to provide a spring lock device as referred to above which is able to differently distribute the locking forces over a wide area so as to significantly reduce the superficial stresses on the rod, ensuring at the same time high

clamping forces and a greater safety factor.

[0014] Yet another object of the present invention is to provide a spring lock device which is constructionally simple, of low-cost and selectively actuable to control the locking force.

BRIEF DESCRIPTION OF THE INVENTION

[0015] The above may be achieved by means of a spring lock device according to claim 1.

[0016] More particularly, the invention provides a spring lock device for high loads to prevent axial or rotational motion of a rod with respect to a housing that surrounds the rod, the lock device comprising at least one locking spring in the form of a coil spring encircling the rod, said coil spring having inside diameter slightly larger than the peripheral diameter of the rod, and control means for wounding the coil spring to grip against the peripheral surface of the rod, characterized in that said coil spring is loosely supported by the rod to allow each coil of the spring to freely move and rotate about an axis orthogonally arranged to the longitudinal axis of the same rod.

[0017] By using coil springs which are made with steel wire of a given diameter and also by using coil springs with a sufficient number of coils or turns, it is possible to exert locking forces which are able to oppose high thrusts, distributing at the same time the stresses over a sufficiently wide area so as to reduce the specific pressures; in this way the risk of damaging the surface of the shaft or rod is largely eliminated or substantially reduced.

[0018] According to the invention, by loosely supporting the spring or leaving each coil of the spring free to oscillate or slightly rotate around an axis orthogonal to the longitudinal axis of the shaft or rod, owing to the misalignment of the coils of the same spring, an increased locking force is obtained to more tightly gripping the rod or the shaft.

[0019] From tests carried out on a 12 mm shaft, with an ISO cylinder of 32 mm supplied with pressurized air at 6 bar (6×10^5 Pa), it has been possible to exert locking forces two or more times greater than those which can be obtained with any known locking device, with a safety coefficient of the order of 2.5 or higher, suitable for highly gripping or safe locking moving parts on machines or mechanical devices.

[0020] The spring lock device according to the invention may be made in any desired shape and size, with a normally open or disengaged spring, by envisaging a suitable form or arrangement of the spring itself as well as the thrusting member and the respective pressure actuated control device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] These and further features of the spring lock device according to the invention, as well as some preferred embodiments thereof, will be more clearly evident from the description of some preferential embodiments and accompanying drawings, in which:

- Fig. 1 is cross-sectional view of a first embodiment of a spring lock device according to the invention, in a normally disengaged condition;
- Fig. 2 is a cross-sectional view similar to that of Figure 1, with the spring lock device in an engaged condition;
- Fig. 3 is a cross-sectional view along line 3-3 of Figure 1;
- Fig. 4 is a cross-sectional view, similar to that of Figure 1, for a second embodiment of the spring lock device according to the invention, in a normally disengaged condition;
- Fig. 5 is a cross-sectional view of the spring lock device of Figure 4 in an engaged condition;
- Fig. 6 is a cross-sectional view, similar to that of Figure 3, showing further features of the spring lock device;
- Fig. 7 is a cross-sectional view, similar to that of Figure 6, showing another solution;
- Fig. 8 is again a cross-sectional view, similar to that of Figure 3, showing the use of two locking springs.

DETAILED DESCRIPTION OF THE INVENTION

[0022] With reference to Figures 1 to 3 we shall describe a first preferential embodiment of a spring lock device according to the invention.

[0023] As shown, the device comprises an external casing 10 defining a chamber 11 for housing a spring locking member 16 which can be pneumatically actuated to prevent and allow a sliding and/or rotational movement of a shaft or rod 12 through guide openings 13, 14 which are axially aligned at the two ends of the casing 10, as shown. Reference 15 in Fig. 1 denotes moreover a cover for the casing 10 comprising a pneumatic cylinder or pneumatically actuated control means 17 for the spring lock device as explained further below.

[0024] The innovative aspect of the lock device according to the invention resides in the use of a locking member 16 provided by at lest one coil spring having a required number of coils or turns, made from steel wire of suitable diameter, as schematically shown.

[0025] The coil spring 16 is encircling the rod 12 and is intended to clamp its coils against the rod 12 so as to lock movement upon actuation. The coil spring 16 is therefore of "normally open" type; for the purposes of the present invention, the expression "normally open" is understood as meaning a coil spring loosely supported by the rod 12 which, in the unstressed condition, have an internal diameter of the coils slightly larger, for example a few tenths of a millimeter greater than the peripheral diameter of the rod 12 against which the said coil spring 12 locks as a result of the gripping force caused by a twisting or coiling action of the control means 17 on

the spring itself.

[0026] In order to exert the necessary twisting action of the coil spring 16, the latter terminates at each end with shaped arms 16A and 16B which are inwardly bent, the end portion of each arm 16A, 16B being bent in a direction parallel to the longitudinal axis of the coil spring 16.

[0027] As previously mentioned, the coil spring 16 is loosely fitted over the rod 12, inside the chamber 11 of the casing 10 to allow each coil of the spring 16 to freely perform a slight longitudinal and/or rotational movement in respect to the rod 12, about an axis perpendicular to the same rod, so as to considerably increase the locking force, as will be explained further on.

[0028] As already mentioned, the gripping action of the coil spring 16 against the rod 12 is performed by a thrust member 18 actuated by a pneumatic cylinder inside the cover 15 of the lock device.

[0029] As shown in the example of figures 1 and 2, the thrust member 18 is in the form of a fork-shaped member downwardly pending from a piston 19 of a pneumatic cylinder. The arms of the fork member 18 have facing sides 18' outwardly slanted or diverging towards the coil spring 16 to engage the arms 16A and 16B of the same coil spring 16.

[0030] The piston member 19 of the pneumatic cylinder, is normally urged toward the lock spring 16 by back springs 20 provided between the piston member 19 and the bottom wall of the cover 15.

[0031] Pressurized air is fed into a side of the piston chamber 21 facing the casing 10, by a feeding conduit 22, while the other side is vented to the atmosphere by a venting hole 23.

[0032] In the example according to Figure 1, the coil spring 16 is normally open that is it does not grip the rod 12 when pressurized air is fed into the piston chamber 21; therefore, in the absence of pressurized air the back spring 20 prevails to forward the piston 19 and the thrust member 18 against the arms 16A, 16B to close the coils of the lock spring 16 against the rod 12 gripping the same; therefore the spring lock device of figure 1 may be referred to as a normally locked device. Obviously by reversing the disposition of the back springs 20 and the air feeding, the spring lock device will be in the form of a normally unlocked device.

[0033] As previously stated, the lock spring 16 is loosely supported by the rod 12 to allow each coil to freely twist and/or rotate around an axis orthogonal to the longitudinal axis of the rod 12, causing twisting of the coils merely by a pushing action on the arms 16A and 16B of the same coil spring. Consequently the coils of the spring 16 will tend to adhere tightly against the peripheral surface of the rod 12, with an increase of the gripping force.

[0034] This may be clearly understood with reference to figure 3 of the drawings; as shown in figure 3 the end coils of the locking spring 16 from which the arms 16A and 16B extend, are slightly contacting the end faces inside the chamber 11 of the casing 10, for example by a pivot point 23, avoiding any contact along a surface or a substantial length of the end coil. Furthermore, the coils of the locking spring 16 may adhere to each other or may be slightly spaced apart to aid twisting of each individual coil of the same spring.

[0035] According to the solution of figures 1 and 2, in order to allow the sliding movement of the rod 12, it will therefore be sufficient to supply pressurised air on the bottom side of the piston 19 opposite to that of the wedge-shaped thrusting element 17. This condition is shown in Figure 1 in which it can be seen that the two arms 16A and 16B of the spring 16 are spaced apart contacting the forward ends of the thrust member 18, thus allowing releasing of the shaft 12; in this condition back springs 20 are urged against the cover 15. Subsequent to the discharge of the air from the pneumatic cylinder, the back springs 20 urge the piston 19 and the thrust member 18 forward, turning the arms 16A, 16B of the locking spring 16 inside to grip rod 12 by twisting the coils of locking spring 16 against the same rod, as shown in figure 2.

[0036] Figures 4 and 5 show a second solution similar to the solution of figures 1 and 2, which makes use of a thrust member of different type; therefore in this case also, the same reference numbers as in the preceding example have been used to indicate similar or equivalent parts.

[0037] The solution of figures 4 and 5 uses a normally open locking spring 16 which is similar to the locking spring 16 of figure 1, with the difference that the spring 16 in Figures 4 and 5 has intersecting arms 16A and 16B against which a disk-shaped thrust member 24 acts. The thrust member 24 is in turn connected to the piston 19 of the pneumatic cylinder via a connecting pin 25 sliding through a guiding hole in partition wall 26 which closes the bottom side of the piston chamber 21 of the cylinder. Back springs 20 are again provided on the side of the piston member 19 which is opposite to the side in which the air feeding conduit 22 opens.

[0038] In the examples described hitherto, the coil spring 16 comes directly into contact with the rod 12 which, consequently, must be made of suitable material or treated to have a harden surface.

[0039] In the case where it is required to use a shaft or a rod 12 made of shaft steel material, it may be advisable to provide a protective annular member between the locking spring 16 and the rod 12 such as a bushing or an intermediate coil spring of material which is softer than the steel material of the rod 12 so as to avoid scoring or damage to the same rod.

[0040] This may be obtained by using a bushing 30 of soft material, for example plastic material, or by arranging annular members of soft metallic material, for example brass material, as schematically shown in Figure 6, or by using an intermediate coil spring 31 having coils arranged between the coils of the locking spring 16, and the rod 12 as schematically shown in Figure 7.

[0041] Figure 8 of the drawings shows a further embodiment which makes use of a pair of locking springs 32, 33 which are co-axially arranged to the rod 12; each spring 32, 33 is provided with respective shaped arms 32A, 32B and 33A, 33B so as to be made close and lock the rod 12 by using a single pressure actuator control device 17, in the manner described above. The two locking springs 32 and 33 may be oppositely wound as shown, or in the same direction. The use of two or more separate locking springs, compared to a single spring of the preceding examples, in certain cases allows an improvement in the locking conditions, also providing an anti-rotational action in the opposite directions.

[0042] In order to verify the effectiveness of the spring lock device, tests were carried out in order to lock a standard pneumatic cylinder having a chamber having 32 mm diameter, and 12 mm rod. The cylinder was supplied initially with pressurized air at a pressure of 5 atm (5×10^5 Pa which was then gradually increased to 17 atm (17×10^5 Pa), achieving locking forces higher than the axial thrust of the cylinder normally ranging, at the test pressures, between 40 and 140 kg. Since the locking device are usually actuated by cylinders supplied with air at 6 atm (6×10^5 Pa) , to which a thrust of 48 kg corresponds for the test cylinder, it is obvious that with a locking device according to the present invention it is possible to obtain locking forces of up to twice and several times greater than that which can be obtained with a conventional locking device.

[0043] It is nevertheless understood that what has been stated and illustrated with reference to the accompanying drawings has been provided purely by way of example of the general principles of the invention and some preferential embodiments and that other modifications or variations may be applied to the device or to part thereof, without departing from the invention.

Claims

1. Spring lock device for high loads to prevent axial or rotational motion of a rod (12) with respect to a housing (10) that surrounds the rod (12), the lock device comprising at least one locking spring in the form of a coil spring (16) encircling the rod (12), said coil spring (16) having inside diameter slightly larger than the peripheral diameter of the rod (12), and control means (18, 19) for wounding the coil spring (16) to grip against the peripheral surface of the rod (12), characterized in that said coil spring (16) is loosely supported by the rod (12) to allow each coil of the spring (16) to freely move and rotate about an axis orthogonally arranged to the longitudinal axis of the same rod (12).

2. Spring lock device according to Claim 1, characterized by comprising at least a first (32) and a second locking springs (33) coaxially arranged with respect to the rod (12).

3. Spring lock device according to Claim 2, characterized in that the locking springs (32, 33) are provided with the same winding direction.

4. Spring lock device according to Claim 2, characterized in that the locking springs (32, 33) are provided with opposite winding directions.

5. Spring lock device according to Claim 1, characterized by comprising a protective bearing member (30, 31) of soften material, coaxially arranged between the locking spring (16) and the rod (12).

6. Spring lock device according to Claim 5, characterized in that said bearing member comprises a plurality of elastically yielding annular elements (30).

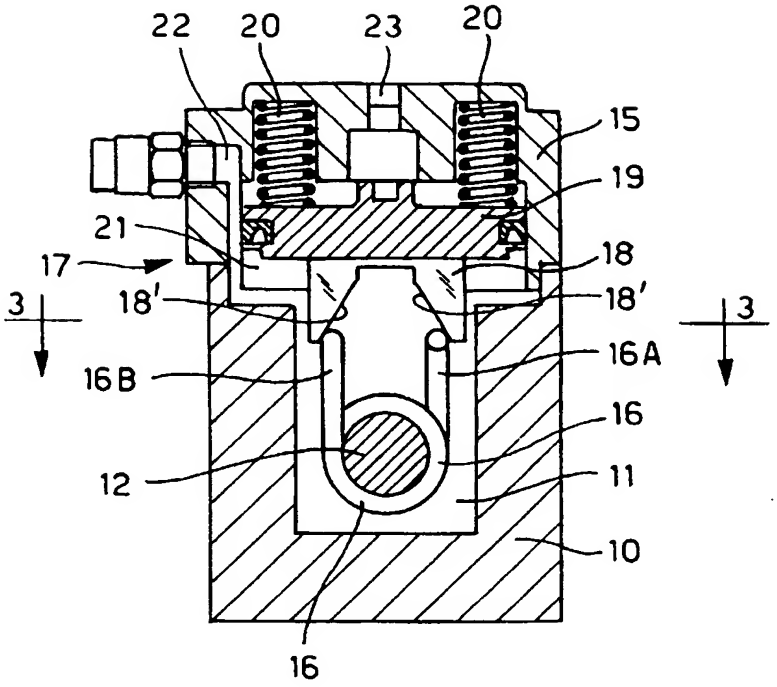
7. Spring lock device according to Claim 5, characterized in that said bearing member consists of at least one coil spring (31).

8. Spring lock device according to claim 1, characterized in that each end face of the casing (10) comprises a pivot point (23) for the end coils of the locking spring (16).

9. Spring lock device according to claim 1 characterized in that the control means (17) comprises a pneumatically cylinder.

10. Spring lock device according to Claim 1, characterized in that the locking spring (16) comprises parallely arranged arms (16A, 16B) longitudinally extending to the rod (12) and in that a pneumatically actuated fork-shaped thrust member (18) having diverging facing surfaces is provided to inwardly urge the end arms (16A, 16B) of the locking spring (16).

11. Spring lock device according to Claim 1, characterized in that the locking spring (16) comprises crossed arms (16A, 16B) longitudinally extending to the rod (12) and in that a pneumatically actuated disk shaped thrust member (24) is provided to outwardly urging the end arms (16A, 16B) of the locking spring (16).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18'
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16A
16B
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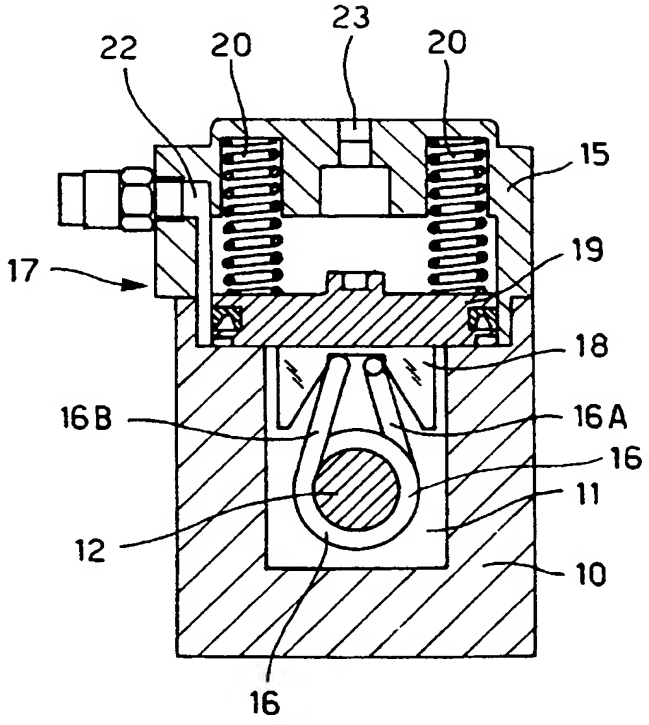
16

FIG. 1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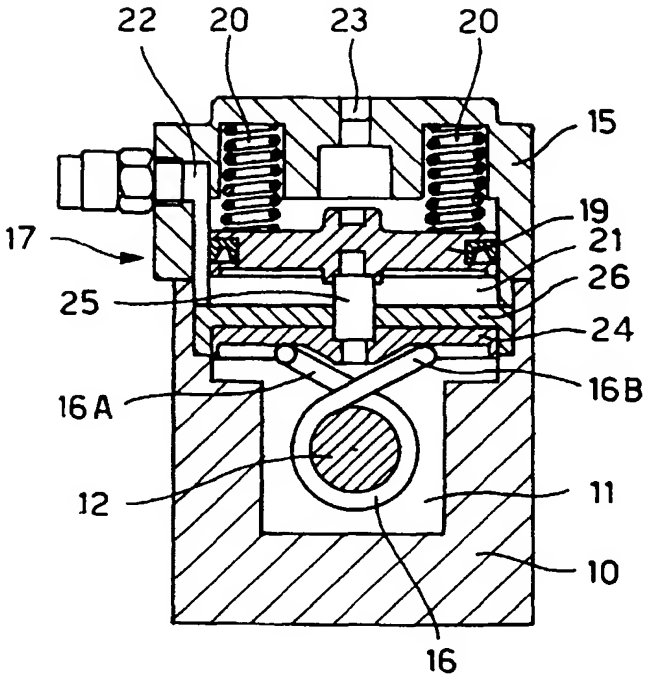
16

FIG. 2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16B
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16A
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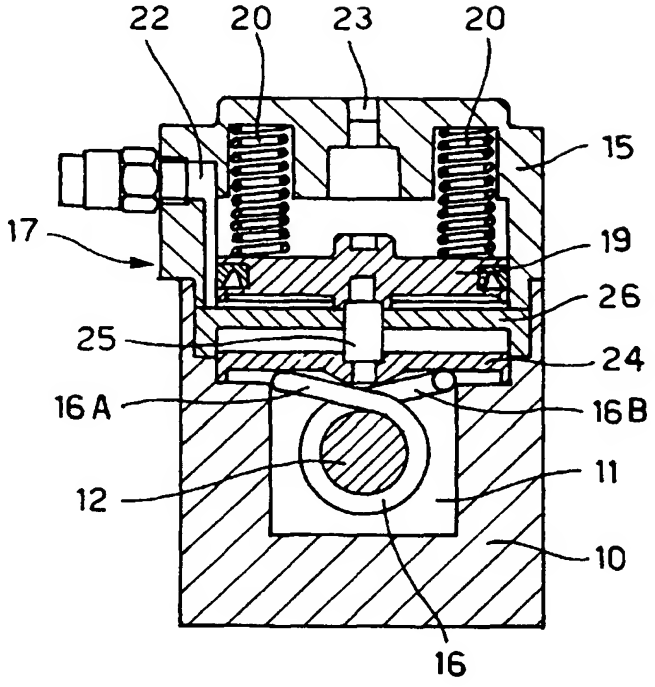
16

FIG. 4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16A
16B
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10
16

FIG. 5

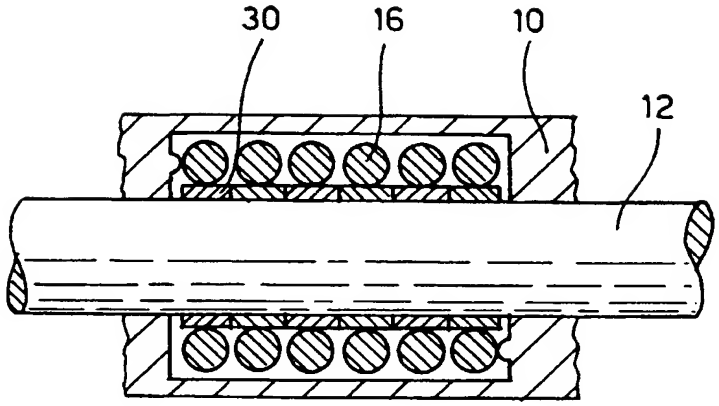

FIG. 6

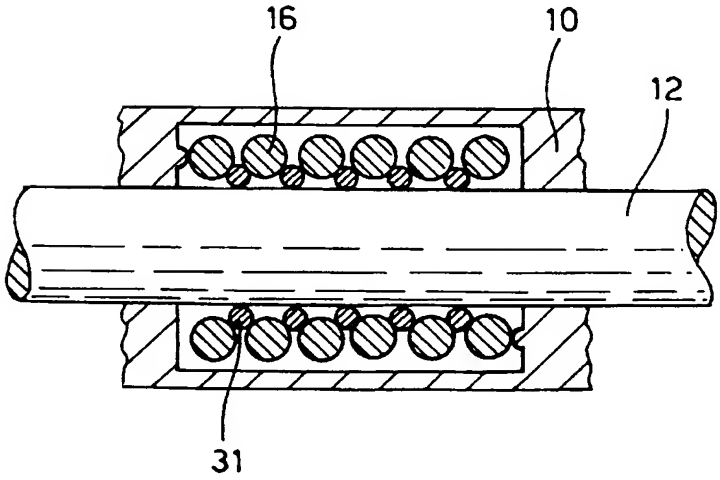

FIG. 7

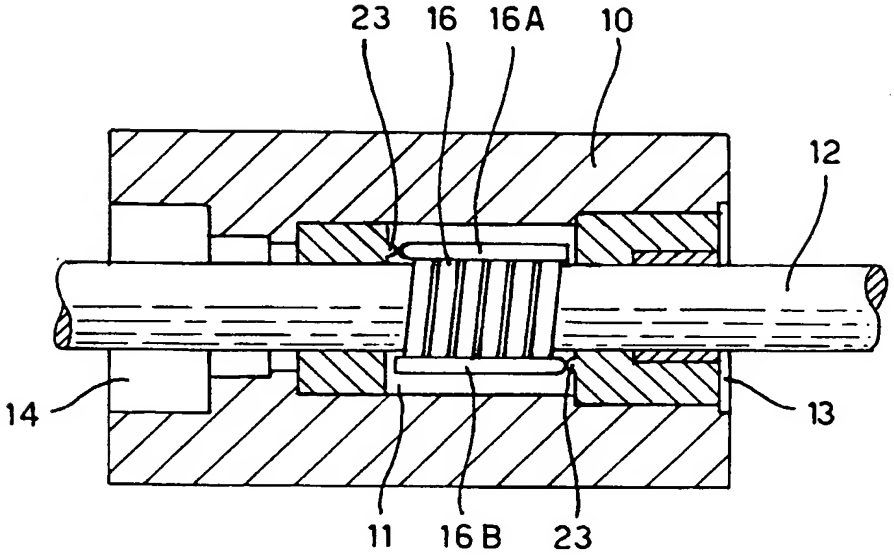

FIG. 3

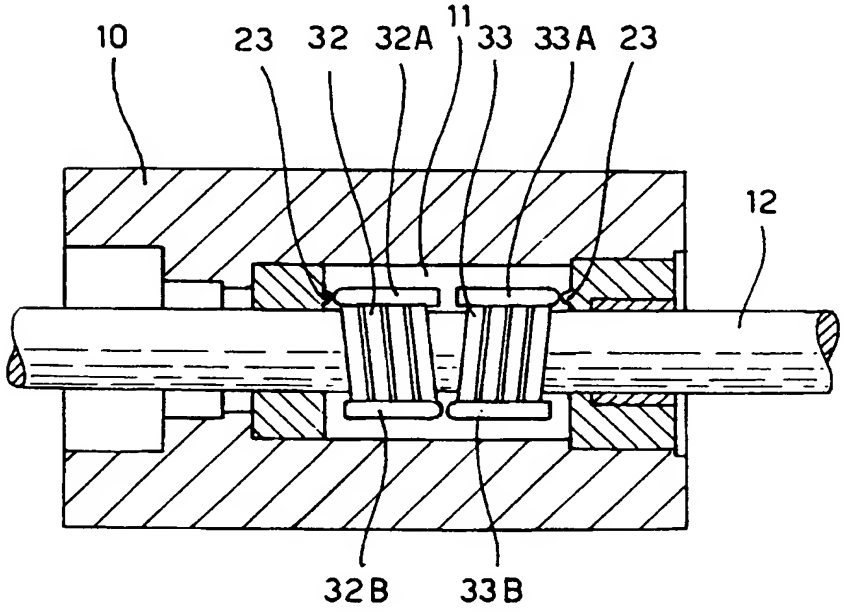

FIG. 8